

SPACE TOXICOLOGY: ENVIRONMENTAL HEALTH CONSIDERATIONS DURING SPACEFLIGHT OPERATIONS & POTENTIAL PATHS FOR RESEARCH. Noreen N. Khan-Mayberry, Ph.D.¹ & Alemalu Sundaresan, Ph.D.², ¹ NASA Johnson Space Center, 2101 NASA Parkway, SF-23, Houston, TX 77058. noreen.n.khan-mayberry@nasa.gov. ² Texas Southern University, 3100 Cleburne Avenue, Houston, TX 77004. Sundaresan_al@tsu.edu

Introduction: Space Toxicology is a specialized discipline for spaceflight, space habitation and occupation of celestial bodies including planets, moons and asteroids [1]. Astronaut explorers face unique challenges to their health while working and living with limited resources for rescue and medical care during space operation. At its core the practice of space toxicology to identify, assess and predict potential chemical contaminants and limit the astronaut's exposure to these environmental factors in order to protect crew health. Space toxicologists are also charged with setting safe exposure limits that will protect the astronaut against a multitude of chemical exposures, in a physiologically altered state. In order to maintain sustained occupation in space, toxicological risks are gauged and managed within the context of isolation, continual exposures, reuse of air and water, limited rescue options, and the necessary use of highly toxic compounds required for propulsion.

As the space program move towards human presence and exploration other celestial bodies *in situ* toxicological risks, such as inhalation of unusual and/or reactive mineral dusts must also be analyzed and controlled. Placing humans for long-term presence in space creates several problems and challenges to the long-term health of the crew, such as bone-loss and immunological challenges and has spurred research into acute, chronic and episodic exposure of the pulmonary system to mineral dusts [2].

NASA has demonstrated that lunar soil contains several types of reactive dusts, including an extremely fine respirable component. In order to protect astronaut health, NASA is now investigating the toxicity of this unique class of dusts. Understanding how these reactive components behave "biochemically" in a moisture-rich pulmonary environment will aid in determining how toxic these particles are to humans. The data obtained from toxicological examination of lunar dusts will determine the human risk criteria for lunar dust exposure and produce a lunar health standard.

It is quite difficult to assess the toxicological implications, due to limited resources of sample material and the challenge of utilizing simulated materials for assessing true toxicity. Another challenge to the traditional toxicologist is trying to assess potential cellular based effects utilizing cell culture

studies For example, certain airway cell lines have lost the ability to form tight junctions, thereby eliminating their ability to produce *in vivo*-like barrier properties as in a real lung. Human cell lines lose critical cellular communication tools such as gap junctions. Hence the experimental effects observed could be erroneous (too subtle or too exaggerated)[3].

Here we discuss the inherent challenges and explore new directions of toxicological research in support of spaceflight operations.

Selected References:

[1] Khan-Mayberry, N.N. & James, J.T. General & Applied Toxicology: Space Toxicology Chapter. J.Wiley. United Kingdom (in press)

[2] Khan-Mayberry, N.N. 2007. The Lunar Environment: Determining the Health Effects of Exposure to Moon Dusts. NASA Scientific and Technical Aerospace Reports (Number 11). May 24, 2007.

[3] Winton HL, Wan H, Cannell MB, Gruenert DC, Thompson PJ, Garrod DR, Stewart GA, Robinson C.: Cell lines of pulmonary and non-pulmonary origin as tools to study the effects of house dust mite proteinases on the regulation of epithelial permeability. *Clin Exp Allergy*. 1998 Oct;28(10):1273-85.